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AN EVALUATION OF SUBSIDENCE CRITERIA FOR THE EAST AND WEST SIDE PANELS, PHALEN MINE, SYDNEY COALFIELD, N.S.

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AN EVALUATION OF SUBSIDENCE CRITERIA FOR THE EAST AND WEST SIDE PANELS, PHALEN MINE, SYDNEY COALFIELD, N.S.

by

T.R.C. Aston*

SUMMARY

Mining on the East and West sides of the proposed Phalen Mine workings will encounter a variety of conditions, which to date have not been encountered elsewhere in the Sydney Coalfield. The 1 and 2 East panels will undermine an area of abandoned, but dry, room and pillar workings in the Lingan Mine, while the 1 and 2 West panels will undermine an area of the old No. 14 Colliery workings which are known to be flooded.

This report examines the subsidence related aspects of the proposed Phalen East and West side panels in relation to the Lingan room and pillar and the flooded No. 14 Colliery workings.

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INTRODUCTION

The Cape Breton Development Corporation (CBDC) is currently developing a new mine, the Phalen Mine, in the Sydney Coalfield. The Phalen Mine will work a resource block in the Phalen Seam, which is located beneath the Lingan Mine Harbour Seam workings. Initially, two areas will be worked, the East and West sides, using retreat mining methods.

Both the proposed East and West side areas, at Phalen, will encounter a variety of conditions which to date, have not been encountered elsewhere in the coalfield. The 1 and 2 West panels will undermine an area of the old No. 14 Colliery workings which are known to be flooded. The question therefore arises, what face width and subsidence criteria should be used to maximise extraction but minimise the risk of a water occurrence in the Phalen workings.

The proposed 1 and 2 East panels will undermine an area of abandoned room and pillar workings in the Lingan Mine Harbour Seam. The questions therefore arise: how much tensile strain will be induced in the Lingan room and pillar workings and at seabed, what effect, if any, would the Phalen subsidence profiles have on the stability of the Lingan pillars and could the pillar between the two Phalen panels be reduced without causing any adverse effects due to subsidence.

This report examines the subsidence related aspects of the proposed Phalen East and West side panels in relation to the No. 14 Colliery and the Lingan room and pillar workings.

SUBSIDENCE PREDICTION

All subsidence calculations undertaken for this report were made using a computer program developed at the Cape Breton Coal Research Laboratory (1,2). The program uses the prediction methods given in the National Coal Board Subsidence Engineers Handbook (NCB SEH) (3).

Two versions of the NCB SEH prediction program were used:

1) The 'K factor' or 's/h multiplier' for the prediction of maximum tensile strain varied between 0.65 and 0.85 for different width/depth ratios (U.K. conditions) (3).

2) The 'K factor' or 's/h multiplier' for the prediction of maximum tensile strain remained constant at 0.80 for different width/depth ratios (Sydney Coalfield conditions) (4).

The NCB Subsidence Engineers Handbook is often viewed as a definitive work on subsidence prediction. However, this can be an erroneous assumption, since it was empirically derived from a data base collected in a variety of U.K. coalfields. Problems occur when it is used in coalfields which were either not included or only poorly represented in the original data base. Similarly, when using empirical methods, it is difficult to quantify the effects of individual parameters such as geology or the presence of existing workings in adjacent seams on the eventual magnitude of the subsidence profile. Caution must therefore be used when applying the NCB SEH to coalfields in countries other than the U.K., even when the conditions to which it is applied are comparable to the coalfields from which the original case histories were collected.

If the Sydney Coalfield is assumed to be similar to the coalfields of the U.K. and the various assumptions and limiting criteria are recognised, the NCB SEH can be used to determine a 'good first order approximation' of the actual subsidence profile.

PHALEN MINE - WEST SIDE PANELS

The location of the proposed Phalen 1 and 2 West panels in relation to the overlying No. 14 Colliery, Harbour Seam workings is shown in Figure 1. The No. 14 Colliery workings are known to be flooded, with an estimated inflow (recharge) rate of 1.364 m^3/min (300 gpm) from outcrop.

The large areal extent and high permeability of the No. 14 Colliery workings combined with their flooded condition means that they should be treated as a major aquifer system located within the overlying strata. Alternatively, because of the large volume of water stored in the workings, they could also be equated to seafloor conditions.

The current maximum tensile strain allowable at seabed in the Sydney Coalfield is 8.5 mm/m. This value was recommended in a report submitted by K. Wardell and Partners to the 1974 Commission of Inquiry into

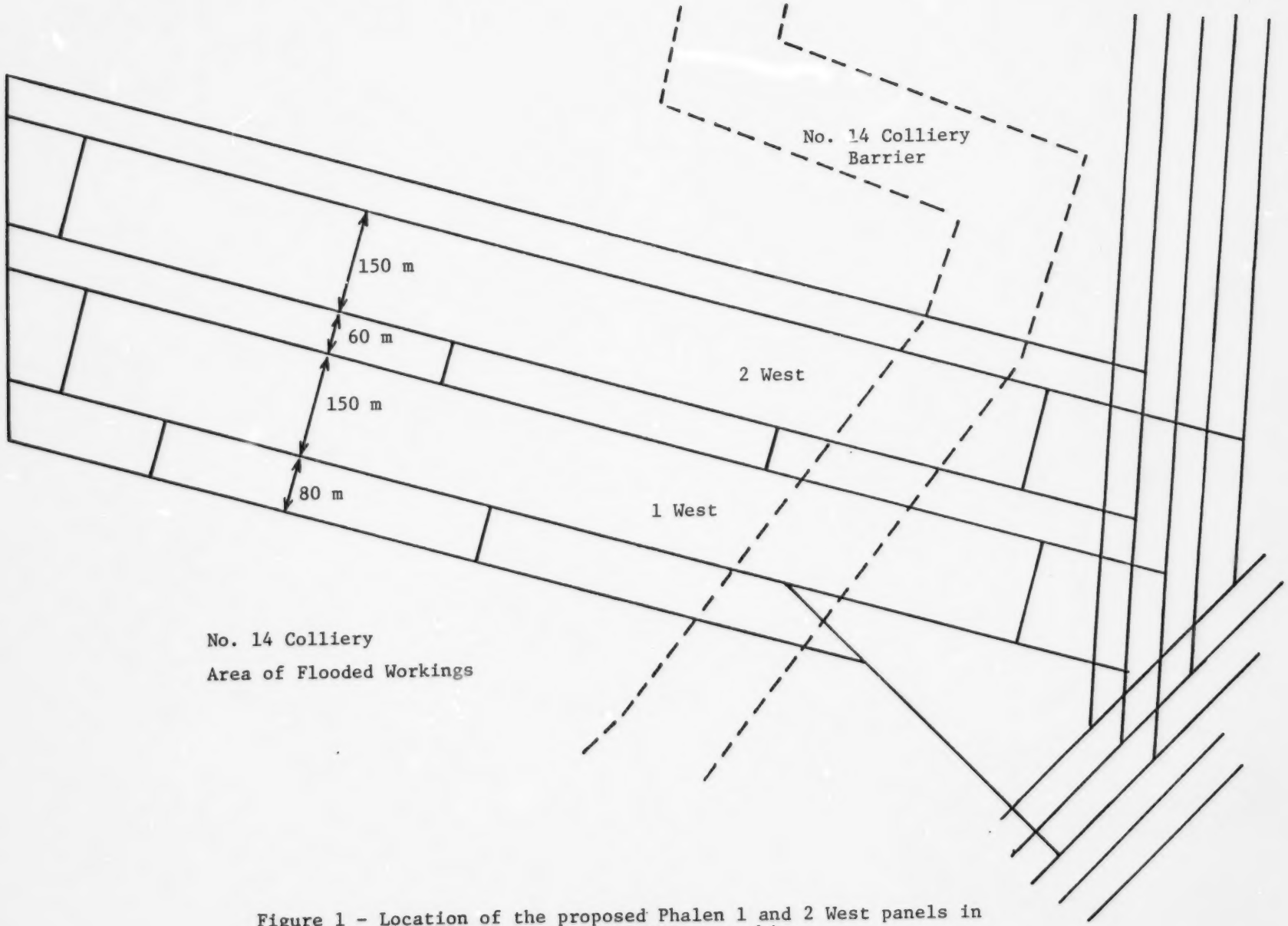

Figure 1 - Location of the proposed Phalen 1 and 2 West panels in relation to the overlying No. 14 Colliery workings

undersea mining in Cape Breton (5). In the U.S.A., a value of 8.75 mm/m tensile strain is recommended (6), while in the U.K. the National Coal Board use a value of 10 mm/m tensile strain (7).

A detailed review of the various seafloor subsidence guidelines (including those derived for the Sydney Coalfield) (5,6,7) revealed questions concerning their validity and applicability to conditions in the Sydney Coalfield. It was therefore concluded, that until such time as further data becomes available, the current guideline value of 8.5 mm/m tensile strain should be adhered to, but only because to date no inundations have occurred in any of the mine workings designed to this value (8,9).

WEST SIDE - MINING PARAMETERS

Subsidence calculations were undertaken using two different 'K' factors: 0.80 (Sydney Coalfield) and 0.65 (U.K. conditions). The working parameters used were:

Face Width	- 180 m
Extracted Seam Height	- 2.13 (7 ft)
Depth of Working	- 135 m
Panel Length	- in excess of 600 m
Seam Gradient	- 1 in 5

The depth of working (135 m) represents the amount of coal measures strata between the proposed Phalen Seam workings and the historical workings in the overlying Harbour Seam. The 135 m of cover is well within the minimum 60 m of cover required by the Coal Mines (CBDC) Safety Regulations (10) between the proposed working horizon and either seabed or a major aquifer horizon.

WEST SIDE - SUBSIDENCE RESULTS

Predicted tensile strain values at the flooded Harbour Seam workings for a variety of panel widths and extracted seam heights are given in Tables 1 and 2.

A panel width of 180 m, at a depth of 135 m and with an extracted seam height of 2.13 m, gives a predicted strain value of about 11.1 mm/m (K = 0.65) and 13.6 mm/m (K = 0.80) on the dip side.

To remain strictly within the existing Sydney Coalfield guideline value of 8.5 mm/m tensile strain, using the current prediction methods, would require a panel width of either 130 m, extracted seam height 1.9 m (8.48 mm/m - K = 0.65) or 100 m, extracted seam height 1.9 m (8.44 mm/m - K = 0.80).

Panel Width (m)	Extracted Seam Height (m)	Depth of Working (m)	Predicted Tensile Strain (mm/m)	Predicted Tensile Strain (mm/m)	
				Rise	Dip
180	2.13	135	8.72	6.36	11.07
180	2.00	135	8.19	5.98	10.40
180	2.25	135	9.21	6.72	11.69
180	2.50	135	10.23	7.47	12.99
100	2.13	135	6.05	4.42	7.68
120	2.13	135	6.87	5.02	8.73
140	2.13	135	7.79	5.69	9.90
150	1.80	135	6.93	5.06	8.81
150	1.90	135	7.32	5.34	9.29
150	2.00	135	7.70	5.62	9.78
150	2.25	135	8.67	6.33	11.01
150	2.50	135	9.63	7.03	12.23
150	2.75	135	10.59	7.73	13.45
150	3.00	135	11.56	8.44	14.68
100	1.80	135	5.11	3.73	6.49
100	1.90	135	5.40	3.94	6.85
120	1.80	135	5.81	4.25	7.37
120	1.90	135	6.13	4.47	7.78
130	1.80	135	6.33	4.62	8.03
130	1.90	135	6.68	4.88	8.48
140	1.80	135	6.59	4.81	8.37
140	1.90	135	6.95	5.08	8.93

Table 1 - Predicted tensile strain at the flooded No. 14 Colliery Harbour Seam workings (NCB SEH, K = 0.65)

Panel Width (m)	Extracted Seam Height (m)	Depth of Working (m)	Predicted Tensile Strain (mm/m)	Predicted Tensile Strain (mm/m)	
				Rise	Dip
180	2.13	135	10.73	7.83	13.63
180	2.00	135	10.07	7.35	12.79
180	2.25	135	11.33	8.27	14.39
180	2.50	135	12.59	9.19	15.99
100	2.13	135	7.45	5.44	9.46
120	2.13	135	8.45	6.17	10.74
140	2.13	135	9.59	7.00	12.18
150	1.80	135	8.53	6.23	10.84
150	1.90	135	9.01	6.58	11.44
150	2.00	135	9.48	6.92	12.04
150	2.25	135	10.67	7.79	13.55
150	2.50	135	11.85	8.65	15.05
150	2.75	135	13.04	9.52	16.56
150	3.00	135	14.22	10.38	18.06
100	1.80	135	6.29	4.59	7.99
100	1.90	135	6.64	4.85	8.44
120	1.80	135	7.15	5.22	9.08
120	1.90	135	7.54	5.51	9.58
130	1.80	135	7.79	5.68	9.89
130	1.90	135	8.22	6.00	10.44
140	1.80	135	8.11	5.92	10.30
140	1.90	135	8.56	6.25	10.87

Table 2 - Predicted tensile strain at the flooded No. 14 Colliery Harbour Seam workings (NCB SEH, K = 0.80)

Using an extracted seam height of 2.13 m, it is not possible to remain within the Sydney Coalfield guideline value of 8.5 mm/m with a panel width greater than 100 m (K = 0.65 or 0.80). However, using the U.S.A. value of 8.75 mm/m, a 120 m panel (K = 0.65 and 2.13 m extraction) would give a

value of 8.73 mm/m. A 120 m panel (K = 0.80 and 2.13 m extraction) gives a value of 10.74 mm/m.

If the U.K. guideline of 10 mm/m is used, a 150 m panel (K = 0.65 and 2.13 m extraction) would give a value of about 10 mm/m tensile strain, while a similar panel using K = 0.80 would result in a value of about 11.7 mm/m.

It has already been stated that considerable uncertainties exist regarding which 'K' factor and hence guideline value should be adopted for the Sydney Coalfield (8,9). In addition, the NCB SEH is recognised as only being able to predict subsidence values within an accuracy of ±10% under U.K. conditions (3). To remain within the Sydney Coalfield value of 8.5 mm/m would require panel widths of under 100 m (using a 2.13 m extraction) or between 100 and 130 m (1.9 m extraction) depending upon which 'K' factor is used. Panel lengths of less than 130 m may not be economically viable in terms of mine layout or development for the Phalen Seam. It is therefore suggested, that since so much uncertainty exists regarding which subsidence prediction method should be used for the Sydney Coalfield, the proposed West side panels should not exceed a width of 150 m (including the width of the gateroads) in order to minimise the risk of water percolation to the Phalen workings. The use of a 150 m panel (K = 0.65 and 2.13 m extraction) keeps the predicted tensile strain within the 10 mm/m guideline value currently used in the U.K.

PHALEN MINE - EAST SIDE PANELS

The location of the proposed Phalen 1 and 2 East panels in relation to the overlying Lingan Mine Harbour Seam workings is shown in Figure 2.

LINGAN 'ROOM AND PILLAR' WORKINGS

The Lingan Mine Harbour Seam workings consist of an area of abandoned 'room and pillar' workings with an approximate pillar size of 24.4 m x 24.5 m (80 ft x 80 ft) on 30.5 m (100 ft) centres. Bad roof conditions (falls of ground) were encountered in several areas of the workings, but no pillar failures were recorded. The workings are not known to be flooded and

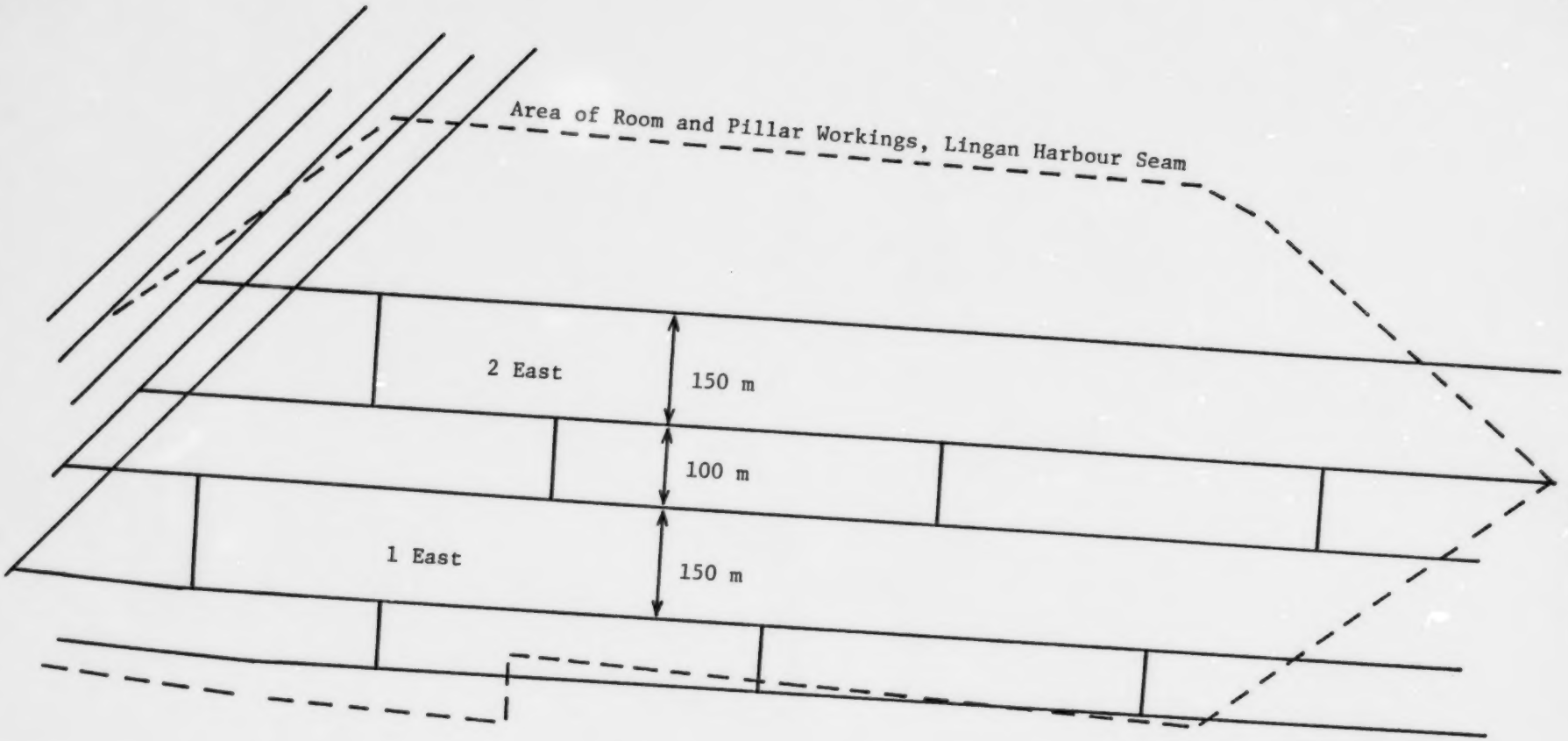

Figure 2 - Location of the proposed Phalen 1 and 2 East panels in relation to the overlying Lingan room and pillar workings

therefore do not constitute a potential aquifer horizon above the proposed Phalen East side panels.

The room and pillar workings have an approximate gradient of 1 in 5 and an average extracted seam height of 2.26 m (7 ft 3 in).

EAST SIDE - MINING PARAMETERS

Subsidence calculations were undertaken using two different 'K' factors: 0.80 (Sydney Coalfield) and 0.65 (U.K. conditions). The working parameters used were:

Face Width	- 150 m
Extracted Seam Height	- 2.13 m (7 ft)
Depth of Working	- to seabed
	(1 East - 300 m and 2 East - 350 m)
	- to Harbour Seam
	(1 East - 163 m and 2 East - 213 m)
Panel Length	- in excess of 700 m
Seam Gradient	- 1 in 5

The depth of working 163 m between the 1 East panel and the Lingan room and pillar workings is well within the minimum 60 m of cover required by the Coal Mines (CBDC) Safety Regulations (10) between the proposed working horizon and either seabed or a potential major aquifer horizon.

EAST SIDE - SUBSIDENCE RESULTS

Lingan Room and Pillar Horizon

Predicted tensile strain values for the 1 and 2 East panels, using a variety of extracted seam heights, at the Lingan room and pillar workings are given in Tables 3 and 4.

The NCB SEH (U.K., K = 0.65) gives a value of 8.46 mm/m on the dip side of 1 East and 3.00 mm/m on the rise side of 2 East. The NCB SEH (Sydney Coalfield, K = 0.80) gives a value of 10.66 mm/m on the dip side of 1 East and 3.43 mm/m on the rise side of 2 East.

A 100 m wide pillar left between the 1 and 2 East panels would result in cumulative tensile strains of 8.9 mm/m (NCB SEH - U.K.) and

Panel Width (m)	Extracted Seam Height (m)	Depth of Working (m)	Predicted Tensile Strain (mm/m)	Predicted Tensile Strain (mm/m) Rise	Dip
	PHALEN EAST 1 PANEL: DEPTH FROM LINGAN HARBOUR SEAM WORKINGS				
150	2.00	163	5.98	3.83	8.13
150	2.13	163	6.22	3.98	8.46
150	2.25	163	6.57	4.20	8.93
150	2.50	163	7.30	4.67	9.93
	PHALEN EAST 2 PANEL: DEPTH FROM LINGAN HARBOUR SEAM WORKINGS				
150	2.00	213	4.40	2.82	5.99
150	2.13	213	4.69	3.00	6.38
150	2.25	213	4.95	3.17	6.74
150	2.50	213	5.50	3.52	7.49

Table 3 - Predicted tensile strain at the Lingan room and pillar Harbour Seam workings (NCB SEH, K = 0.65)

Panel Width (m)	Extracted Seam Height (m)	Depth of Working (m)	Predicted Tensile Strain (mm/m)	Predicted Tensile Strain (mm/m) Rise	Dip
	PHALEN EAST 1 PANEL: DEPTH FROM LINGAN HARBOUR SEAM WORKINGS				
150	2.00	163	7.36	4.71	10.01
150	2.13	163	7.84	5.02	10.66
150	2.25	163	8.28	5.30	11.26
150	2.50	163	9.20	5.89	12.52
	PHALEN EAST 2 PANEL: DEPTH FROM LINGAN HARBOUR SEAM WORKINGS				
150	2.00	213	5.03	3.22	6.84
150	2.13	213	5.36	3.43	7.29
150	2.25	213	5.66	3.62	7.70
150	2.50	213	6.29	4.03	8.56

Table 4 - Predicted tensile strain at the Lingan room and pillar Harbour Seam workings (NCB SEH, K = 0.80)

11.1 mm/m (NCB SEH - Sydney Coalfield) at the Lingan room and pillar horizon. The effect of reducing the pillar size on the cumulative tensile strain at the room and pillar horizon is shown in Figure 3 and Table 5. Complete removal of the pillar would result in predicted cumulative tensile strains of 10.8 mm/m (NCB SEH - U.K.) and 13.3 mm/m (NCB SEH - Sydney Coalfield).

A 50% reduction in pillar width (50 m instead of 100 m) would only result in an increase of 0.7 mm/m tensile strain or 27% of the difference in cumulative tensile strain between a 100 m and 10 m pillar, using the NCB SEH (U.K., K = 0.65) method.

It is interesting to note that the cumulative tensile strain at the Lingan room and pillar workings, 8.9 mm/m using the NCB SEH - U.K. option, is very close to the Sydney Coalfield guideline value of 8.5 mm/m used for undersea mining.

Seabed - Room and Pillar Workings Stable

If the pillars in the Lingan 'room and pillar' workings are assumed to remain stable, even when undermined by the proposed 1 and 2 East panels, the predicted subsidence profiles at seabed can be assumed to result from single seam conditions.

Predicted tensile strains at seabed (assuming single seam conditions) are 3.79 mm/m on the dip side of 1 East and 1.25 mm/m on the rise side of 2 East using both the NCB SEH (U.K. and Sydney Coalfield) options, Tables 6 and 7.

The greatest tensile strain value that could be induced at seabed would occur if the maximum tensile strains on the dip side of 1 East and the rise side of 2 East coincided, resulting in a value of 5.04 mm/m. The pillar between the 1 and 2 East Phalen panels could therefore be removed and the tensile strain at seabed still remain within the 8.5 mm/m guideline used in the Sydney Coalfield.

Seabed - Room and Pillar Workings Unstable

If pillars in the Lingan 'room and pillar' workings became unstable during undermining and collapsed, the final subsidence profile at seabed would result from the superimposition of the Phalen panels and the area of collapsed room and pillar workings.

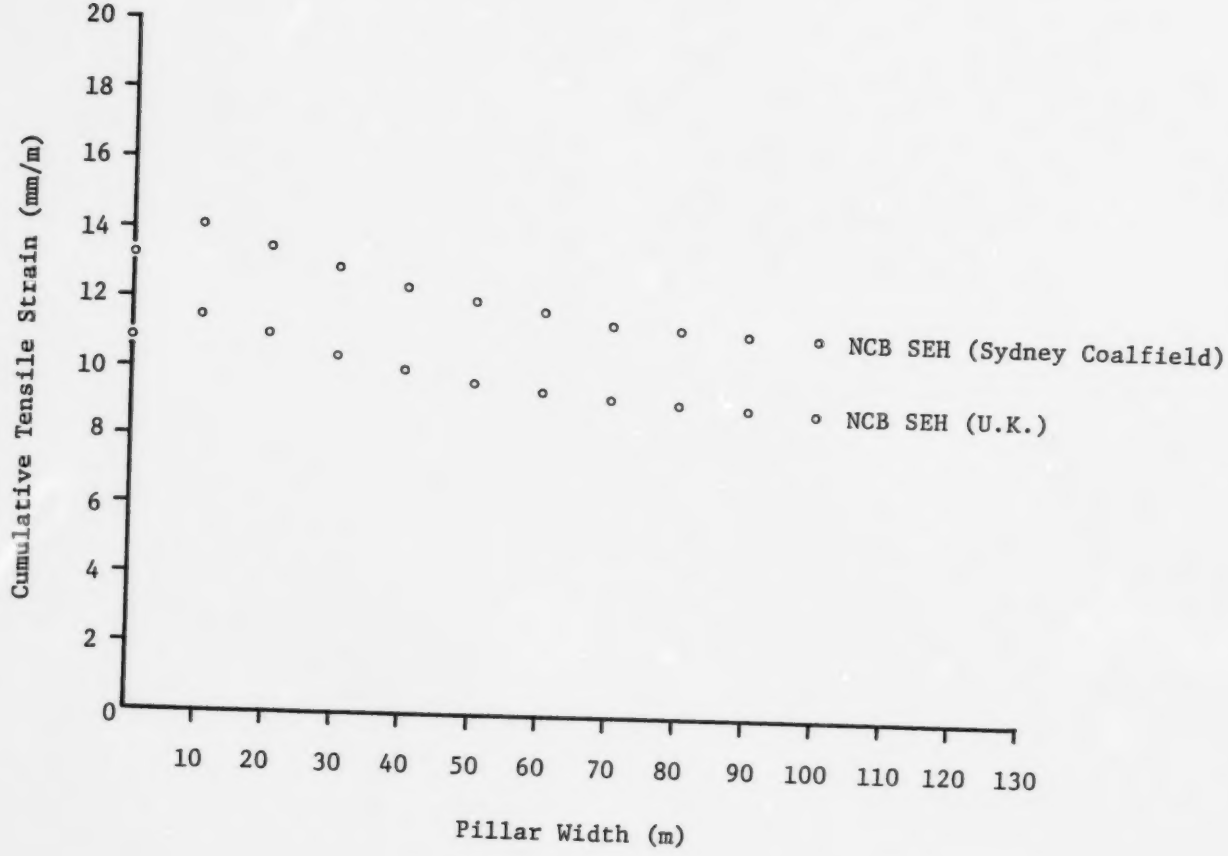

Figure 3 - Cumulative tensile strains at the Lingan Harbour Seam versus pillar width, Phalen east side workings

Pillar Width (m)	Cumulative Tensile Strains - Lingan Harbour Seam (mm/m) NCB SEH (U.K.)	NCB SEH (Sydney Coalfield)
100	8.9	11.1
90	9.0	11.2
80	9.1	11.3
70	9.2	11.4
60	9.4	11.7
50	9.6	12.0
40	10.0	12.4
30	10.4	12.9
20	11.0	13.5
10	11.5	14.1
0	10.8	13.3

Table 5 - Cumulative tensile strains (Lingan Harbour Seam) pillar widths (Phalen 1 and 2 East panels)

Panel Width (m)	Extracted Seam Height (m)	Depth of Working (m)	Predicted Tensile Strain (mm/m)	Predicted Tensile Strain (mm/m)	
				Rise	Dip
	PHALEN EAST 1 PANEL:		**DEPTH FROM SEABED**		
150	1.80	300	2.35	1.51	3.20
150	1.90	300	2.48	1.59	3.38
150	2.00	300	2.61	1.67	3.55
150	2.13	300	2.78	1.78	3.79
150	2.25	300	2.94	1.88	4.00
150	2.50	300	3.27	2.09	4.44
150	2.75	300	3.59	2.30	4.89
150	3.00	300	3.92	2.51	5.33
	PHALEN EAST 2 PANEL:		**DEPTH FROM SEABED**		
150	1.90	350	1.74	1.11	2.36
150	2.00	350	1.83	1.17	2.49
150	2.13	350	1.95	1.25	2.65
150	2.25	350	2.06	1.32	2.80
150	2.50	350	2.29	1.46	3.11
150	2.75	350	2.51	1.61	3.42

Table 6 - Predicted tensile strain at seabed (NCB SEH, K = 0.65)

Panel Width (m)	Extracted Seam Height (m)	Depth of Working (m)	Predicted Tensile Strain (mm/m)	Predicted Tensile Strain (mm/m)	
				Rise	Dip
		PHALEN EAST 1 PANEL: DEPTH FROM SEABED			
150	1.80	300	2.35	1.51	3.20
150	1.90	300	2.48	1.59	3.38
150	2.00	300	2.61	1.67	3.55
150	2.13	300	2.78	1.78	3.79
150	2.25	300	2.94	1.88	4.00
150	2.50	300	3.27	2.09	4.44
150	2.75	300	3.59	2.30	4.89
150	3.00	300	3.92	2.51	5.33
		PHALEN EAST 2 PANEL: DEPTH FROM SEABED			
150	1.90	350	1.74	1.11	2.36
150	2.00	350	1.83	1.17	2.49
150	2.13	350	1.95	1.25	2.65
150	2.25	350	2.06	1.32	2.80
150	2.50	350	2.29	1.46	3.11
150	2.75	350	2.51	1.61	3.42

Table 7 - Predicted tensile strain at seabed (NCB SEH, K = 0.80)

Limited research has been undertaken on the behaviour of room and pillar workings when undermined by longwall panels. However, a study in the Northumberland Coalfield, U.K., where permeability changes occurring around longwall panels were monitored from overlying room and pillar workings, revealed that extensive roof collapses and pillar spalling occurred when undermining took place (11, 12). It is not known if the coal pillars failured completely.

In the case of the Lingan room and pillar workings, it is assumed that the worst case would occur if total pillar failure took place across an area equivalent to each of the proposed Phalen panels. This would result in the formation of a collapsed area equivalent to a longwall panel, located directly above each of the Phalen panels.

Predicted tensile strains at seabed for the individual panels in both the Phalen and Lingan workings are given in Table 7.

	NCB SEH (K = 0.65)			
	Phalen		Lingan	
	Rise	Dip	Rise	Dip
1 East	1.78	3.79	5.49	11.67
2 East	1.25	2.65	3.52	7.48

	NCB SEH (K = 0.80)			
	Phalen		Lingan	
	Rise	Dip	Rise	Dip
1 East	1.78	3.79	6.76	14.36
2 East	1.25	2.65	4.33	9.21

Table 8 - Predicted tensile strain at seabed for the Phalen panels and the Lingan pillar failure areas (NCB SEH, K = 0.65 and 0.80)

Maximum cumulative tensile strains for the superimposition of the Phalen and Lingan panels, with a 100 m pillar (in the Phalen, would be 15.1 mm/m (NCB SEH, K = 0.65) and 17.9 mm/m (NCB SEH, K = 0.80).

A reduction in the width of the Phalen pillar would result in gradually increasing strains (similar to those seen in Figure 3). The worst case would occur with a 10 m pillar, when the maximum predicted tensile strain at seabed would be 18.3 mm/m (NCB SEH, K = 0.65) and 21.8 mm/m (NCB SEH, K = 0.80).

If the area of pillar collapse in the Lingan workings resulted in an equivalent panel of less than 150 m, say 110 m or 70 m, the resulting individual and cumulative tensile strains at seabed would be less than the worst case values stated for the 150 m panel.

DISCUSSION

A detailed discussion regarding the application of existing prediction techniques and seafloor subsidence guidelines to the Sydney Coalfield can be found elsewhere (8,9).

It is recognised that the NCB SEH cannot be used to accurately predict subsidence in the U.S. Appalachian and mid-west coalfields. However, although the Sydney Coalfield appears to be a northern extension of the Appalachian Coalfield, it also bears marked geological/structural similarities to the U.K. coalfields. It is therefore concluded, that given the wide range of conditions under which the NCB SEH data was collected, the SEH can be applied to the Sydney Coalfield providing it is realised that the error may be greater than the ±10% normally quoted (3).

In the event of the Lingan room and pillar workings becoming unstable due to undermining, it is not known how extensive the potential area of pillar collapse would be. Limited research in this field has noted events such as roof falls and pillar spalling, but has not determined whether an extensive area of total pillar failure actually occurs. It is unlikely that the mechanism of pillar failure would be associated with vertical subsidence displacement, but rather areas of high tensile rather than compressive strain.

In the East Midlands Coalfield, U.K., research has shown 'that for first seam working, subsidence never exceeded 80% of the extracted seam height, while for second and subsequent seam workings, a value of 90% extracted seam height occurs for critical areas' (9). At present, the effect

of multiseam extraction on subsidence prediction in the Sydney Coalfield is unknown.

To date, no subsidence data has been obtained to calculate actual seabed strains over the longwall panels or evaluate the factor of safety contained within the existing subsidence guidelines for the Sydney Coalfield. It is therefore essential to undertake a field program to obtain sufficient data for the determination of Sydney Coalfield specific subsidence coefficients. The field program should be implimented as soon as possible in view of multiseam conditions at the current Phalen and proposed Donkin-Morien mines. Undermining the Lingan room and pillar workings would provide a unique opportunity to monitor the real-time development of subsidence profiles in the Sydney Coalfield, as well as determine the effects of subsidence on the stability of room and pillar workings.

CONCLUSION

Mining on the East and West sides of the proposed Phalen workings will encounter a variety of conditions, which to date have not been encountered elsewhere in the Sydney Coalfield.

The west side panels will undermine an area of flooded workings in the No. 14 Colliery Harbour Seam and it is suggested that to minimise the potential risk of water percolation to the Phalen workings, the panels should not exceed a width of 150 m.

The East side panels will undermine an area of abandoned, but dry, room and pillar workings in the Lingan mine. If the pillars remain stable during undermining, the predicted tensile strains at seabed will remain within the current guideline value of 8.5 mm/m. However, if extensive pillar failure occurs, then under 'worst case' conditions the predicted tensile strain at seabed could vary between 18 and 22 mm/m.

REFERENCES

1. Zinck, D.D. and Aston, T.R.C. "'SUB #4' users guide: IBM-PC/AT computer calculation of longwall subsidence profiles using the NCB Subsidence

Engineers Handbook"; Division Report ERP/CRL 86-79(TR); CANMET, Energy, Mines and Resources Canada; 1986.

2. Aston, T.R.C. "Prediction of longitudinal and subsidence profiles with width/depth ratios in excess of 3.0 using National Coal Board Methods"; Division Report ERP/CRL 86-80(TR); CANMET, Energy, Mines and Resources Canada; 1986.
3. National Coal Board (U.K.); "Subsidence Engineers Handbook"; Mining Department; London, U.K.; 1975.
4. "Personal Communication"; Cape Breton Development Corporation, Sydney, N.S., Canada.
5. Wardell, K. and Partners "Report to the Commission of Inquiry 1974 on the question of submarine mining in Cape Breton"; November 1974.
6. Wardell, K. and Partners "Guidelines for mining under surface water, Phase III, Final Report"; Bureau of Mines; Washington, DC; Publication PB 264-729; May 1976.
7. National Coal Board (U.K.) "Working under the sea"; Production Department Instruction; PI/1968/8.
8. Aston, T.R.C. "A review and evaluation of undersea subsidence criteria used in the Sydney Coalfield, N.S."; Division Report ERP/CRL 85-85(TR); CANMET, Energy, Mines and Resources Canada; 1985.
9. Aston, T.R.C. " A review and evaluation of undersea subsidence criteria used for the Donkin-Morien Definition Study"; Division Report ERP/CRL 85-90(CF); CANMET, Energy, Mines and Resources Canada; 1985.
10. Canada Labour (Safety) Code, "Coal Mines (CBDC) Safety Regulations PC 1969", SOR/69-31, p. 31, Regulation 115.
11. Neate, C.J. "Effects of mining subsidence on the permeability of coal measures rocks"; Ph.D. Thesis, University of Nottingham, U.K.; October 1980.
12. Neate, C.J. "Personal Communication"; Department of Mining Engineering; University of Nottingham; U.K.